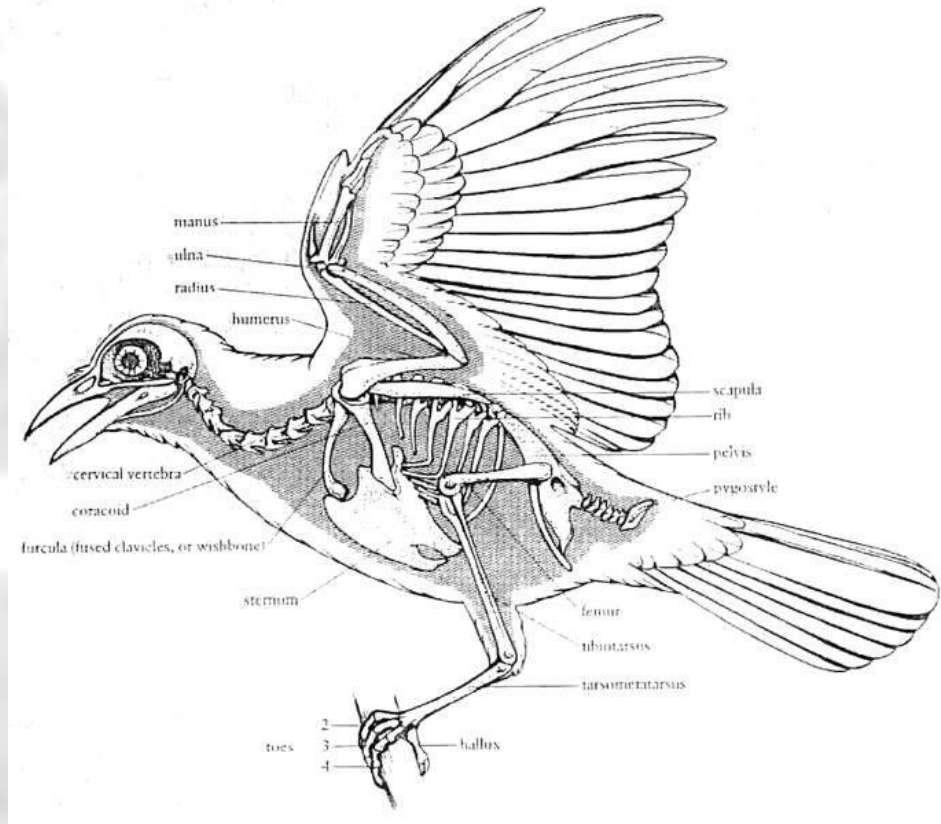


Variance in Avian Leg Bone Structure

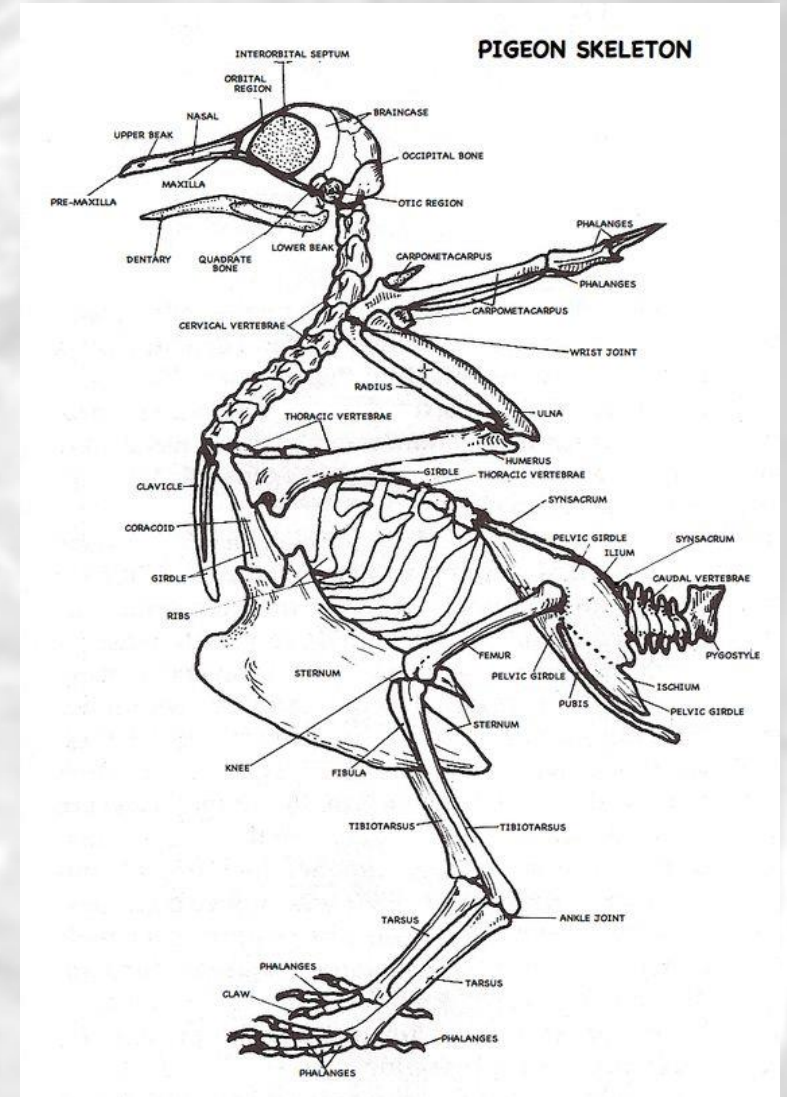
Lydia Jones

Data from the *Natural History Museum of Los Angeles County's* Ornithology collection



Dataset Background

- 420 bird skeletons measured.
- Measured length and diameter of humerus, ulna, femur, tibiotarsus, and tarsometatarsus.
- The dataset covers 6 ecological types of birds:
 - Swimming Birds
 - Wading Birds
 - Terrestrial Birds
 - Raptors
 - Scansorial Birds
 - Singing Birds



Background cont.

- 53 Raptors and 119 Swimming Birds measured.
- Tarsometatarsus: a bone that is only found in the lower leg of birds and some dinosaurs.
 - Formed from the fusion of several bones in humans (the tarsal and metatarsal).



Example of tarsometatarsus in Heterodontosaurus tucki.

Hypothesis

- Birds of different ecological types have clear morphological differences reflective of their living habits.
- Swimming birds use their legs primarily for locomotion through water.
- Raptors use their legs and feet to hunt.
- Therefore...Raptors are more likely to have longer tarsometatarsi, because this would increase their reach.



Descriptive Statistics

<i>Swimming Birds</i>	
Mean	45.15621
Standard Error	1.940207
Median	39.695
Mode	#N/A
Standard Deviation	20.89667
Sample Variance	436.6708
Kurtosis	1.39611
Skewness	1.157934
Range	109.93
Minimum	18.42
Maximum	128.35
Sum	5238.12
Count	116

<i>Raptors</i>	
Mean	59.16633
Standard Error	2.727822
Median	60.19
Mode	#N/A
Standard Deviation	19.09476
Sample Variance	364.6097
Kurtosis	-0.4346
Skewness	-0.27105
Range	80.62
Minimum	19.1
Maximum	99.72
Sum	2899.15
Count	49

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Two Sample t-Test

t-Test: Two-Sample Assuming Unequal Variances		
	<i>SW Tarl</i>	<i>R Tarl</i>
Mean	45.1562069	59.16633
Variance	436.6708203	364.6097
Observations	116	49
Hypothesized Mean Difference	0	
df	98	
t Stat	-4.185311774	
P(T<=t) one-tail	3.10896E-05	
t Critical one-tail	1.660551217	
P(T<=t) two-tail	6.21792E-05	
t Critical two-tail	1.984467455	

- Shows significant difference in the mean tarsometatarsus lengths of swimming bird vs. raptors.
- The absolute value of the T-stat is $>$ than the T-Crit.
- The P value is $<$ than 0.05α

Visualization of Data

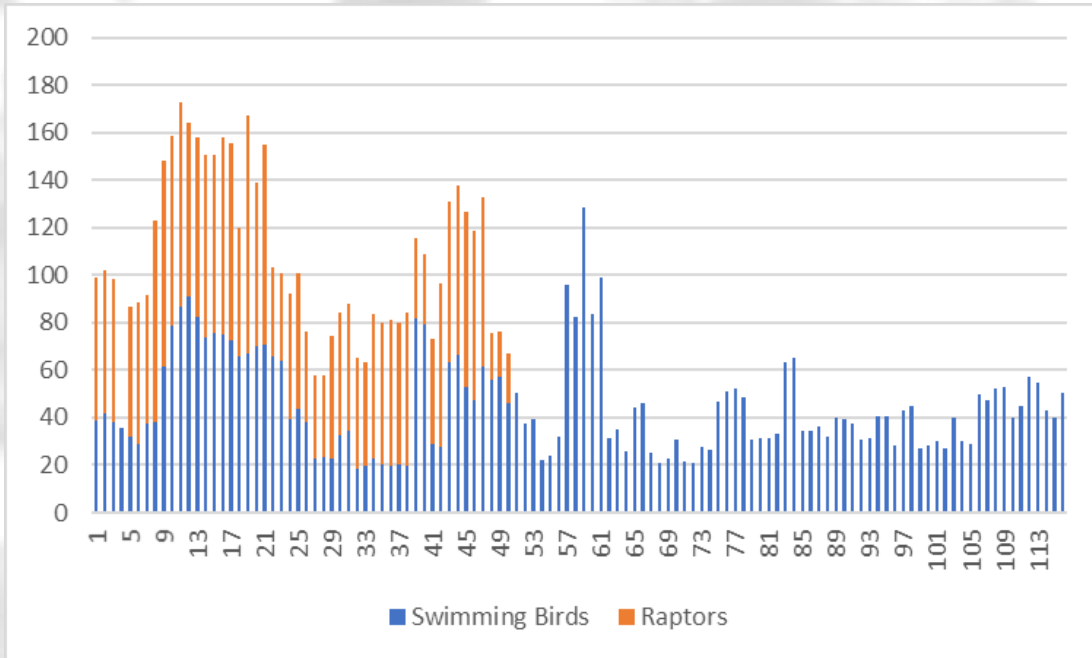


Figure 1. distribution of tarsometatarsus lengths among samples from swimming birds and raptors.

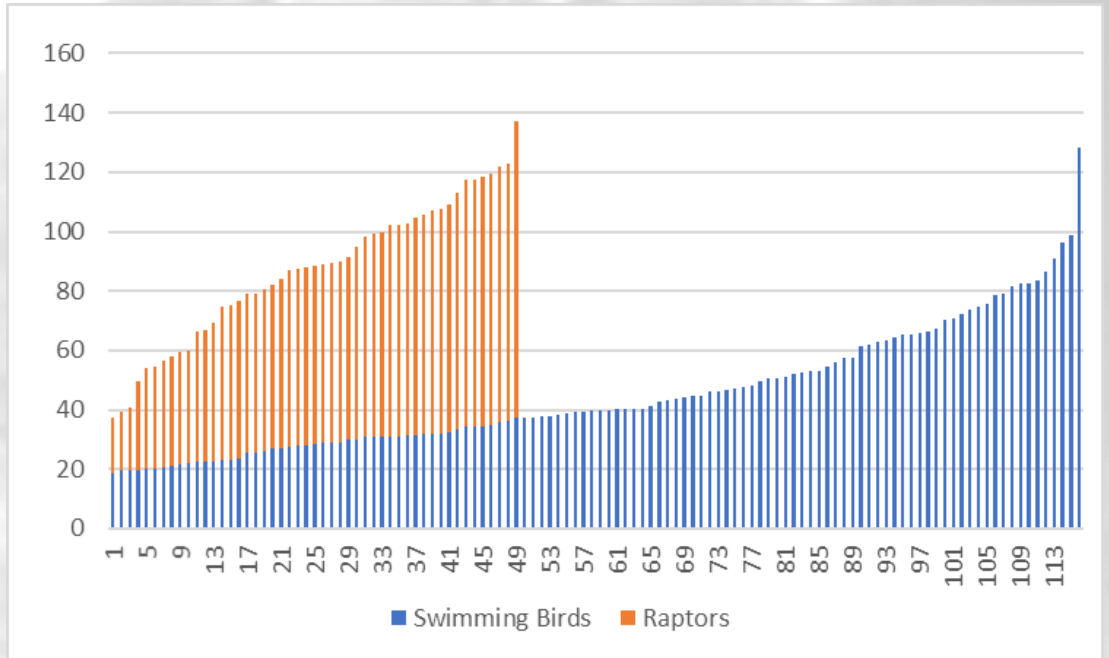


Figure 2. distribution of tarsometatarsus lengths among samples from swimming birds and raptors, ordered highest to lowest length.

Visualization of Data cont.

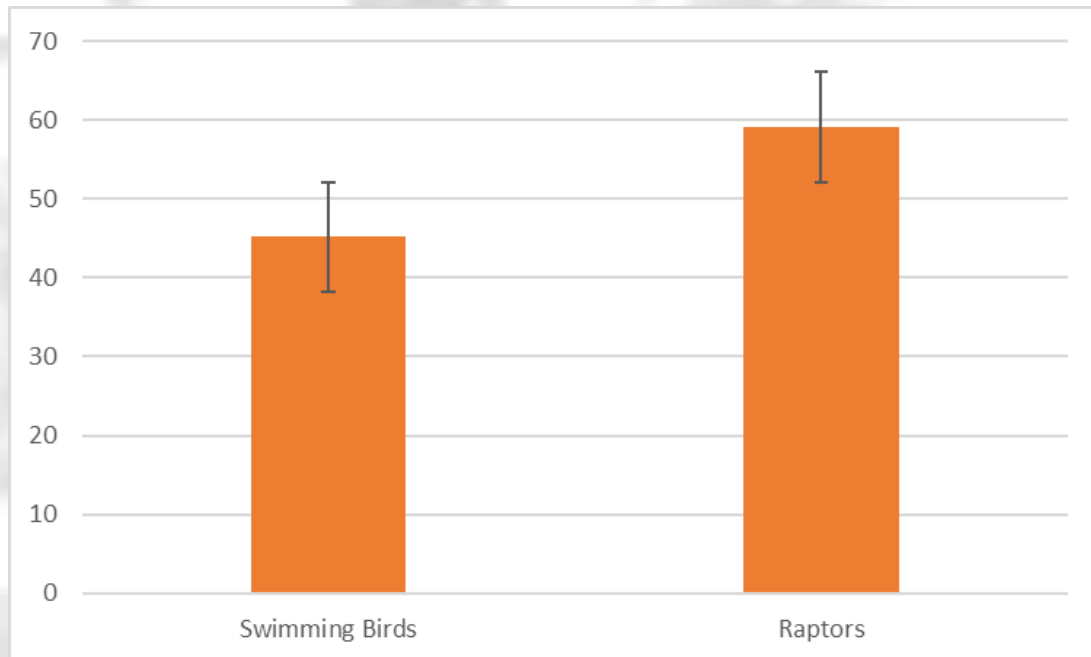


Figure 3. mean tarsometatarsus lengths of swimming birds vs. raptors.

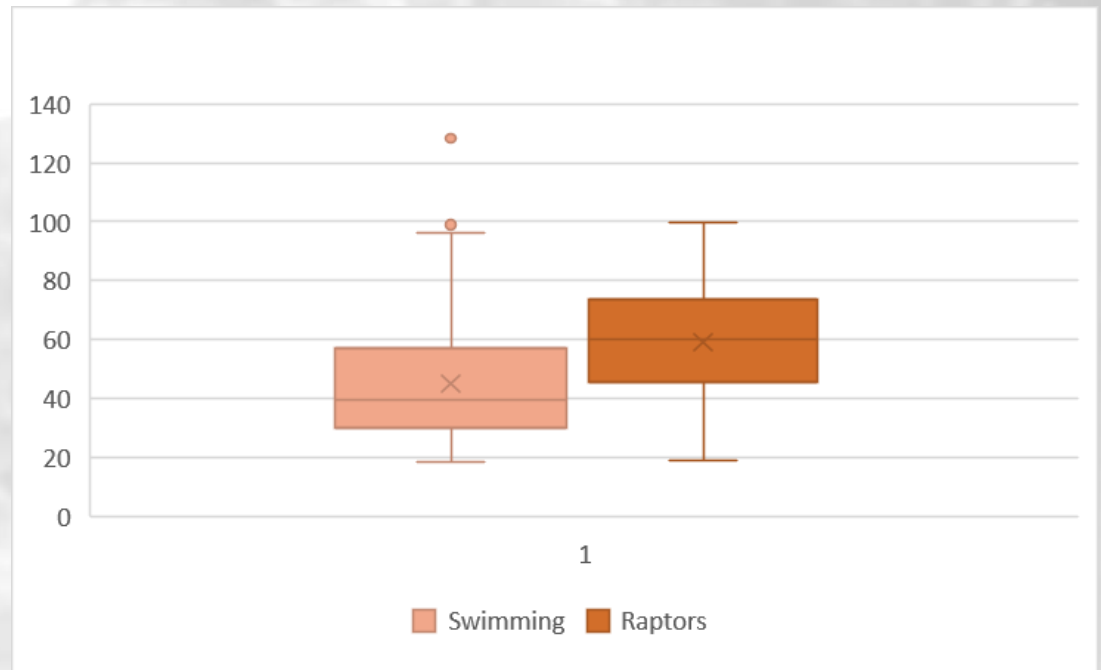
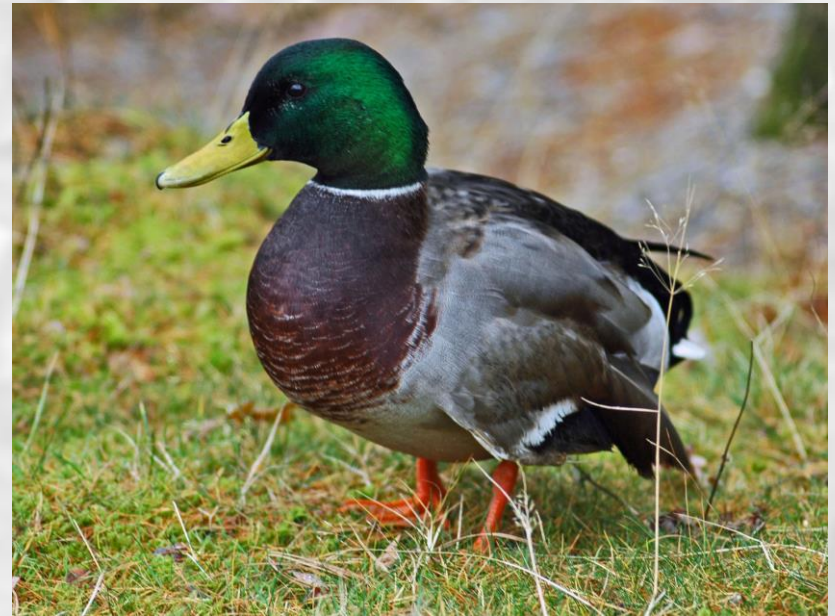


Figure 4. tarsometatarsus lengths of swimming birds vs. raptors.

Conclusions

- There is significant enough statistical evidence to suggest that in this dataset, Raptors have longer tarsometatarsi than Swimming birds.
- This is most likely due to an adaption to different living conditions.



Works Cited

- “Bird Skeleton” *Encyclopaedia Britannica*. <https://www.britannica.com/animal/bird-animal/Skeleton#ref875948>
- Liu, D. “Bird bones and living habits.” *Natural History Museum of Los Angeles County*. Retrieved from <https://www.kaggle.com/zhangjuefei/birds-bones-and-living-habits/home>
- Sereno, P.C. 2012. “Taxonomy, morphology, masticatory function and phylogeny of heterodontosaurid dinosaurs” *ZooKeys* **226**: 1-225.